MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

ECE 3086 – MULTIMEDIA TECHNOLOGIES AND APPLICATIONS

(All sections / Groups)

27 OCTOBER 2018
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTION TO STUDENTS

1. This question paper consists of 6 pages (including cover page) with 5 questions.
2. Attempt all **FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer Booklet provided.

QUESTION 1

(a) With the use of a suitable diagram, explain how the Pulse Code Modulation (PCM) technique converts an analogue sound signal into a digital audio signal. The explanation must describe the three major components inside PCM, mainly the band-limiting filter, the 'sample and hold' block and the quantizer.

[8 Marks]

(b) A PCM digitized speech signal is desired to be transmitted over a network with bandwidth capacity of 128 kb/sec. The sampling rate used is 8000 samples/sec.

i) Assume that 32 bits are used for each encoded sample and mono sound is used. Can the digitized data be transferred over the network? Justify your answer based on your shown calculation.

[4 Marks]

ii) Calculate the optimal bits depth for the signal. Explain the impact of using this new bit depth value with regards to signal quality. Suggest a method to reduce the bit rate without significantly affecting the speech signal quality.

[4 Marks]

(c) A digitized true colour bitmap image is encoded with 24 bits per pixel. The image resolution is 640x480. Compute the image size in bytes. The image is transformed to 256 indexed colours. Compute the new image size.

[4 Marks]

Continued ...

QUESTION 2

(a) Compression methods based on entropy coding are commonly used for lossless compression. Consider two different text files with the same number of words. One of the text files contains words that are randomly generated and the other text file is taken from a local news. Which text file will give lower compression ratio using Huffman coding? Justify your answer. (Assume compression ratio CR = size of data before compression / size of data after compression)

[4 Marks]

(b) You are given a text data that are composed of only four characters in the set S = {a, b, c, d}. A study on the distribution of the characters in the text data has been performed and the frequency distribution is shown in Table 1. Design an optimal fixed length code and a Huffman code (variable length code) that will use the least number of bits. You will need to show the codes for all the 4 characters. Which code gives higher compression if 8 bits fixed length ASCII code is used before compression?

Table 1

characters	a	b	c	d
frequency	60	5	30	5

[10 Marks]

(c) Table 2 shows a new set of colour-matching functions $\bar{x}^{new}(\lambda)$, $\bar{y}^{new}(\lambda)$ $\bar{z}^{new}(\lambda)$ with the values listed. Compute the chromaticity value (x, y) for white light with spectral power density E(λ) = 0.8 for all λ

Table 2

λ (nm)	$\bar{x}^{new}(\lambda)$	$\bar{y}^{new}(\lambda)$	$\bar{z}^{new}(\lambda)$
450	0.2	0.1	0.5
500	0.1	0.4	0.3
600	0.1	0.4	0.2
700	0.6	0.1	0.0

[6 Marks]

Continued ...

QUESTION 3

(a) The JPEG (Joint Photographic Experts Group) compression technique exploits the observations on image properties and human vision to achieve high image compression. Briefly explain how JPEG uses these observations in the JPEG image compression algorithm.

[9 Marks]

(b) Draw the complete JPEG **encoder and decoder** block diagram.

[6 Marks]

(c) Figure 1 shows a 5x5 grayscale image with the gray levels shown. A 3x3 mean filter with the mask M1 as shown in Figure 2 is applied to the image. After mean filtering, compute the new pixel value for the highlighted pixels at position (2,2), (2, 3) and (3, 2). What is the effect of the filter on the appearance of the image?

[5 Marks]

25	25	25	25	20
25	16	16	16	20
25	16	16	16	20
25	16	16	16	20
25	10	10	10	20

Figure 1

Mask M1

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

Figure 2

Continued ...

QUESTION 4

(a) Figure 3 shows the block diagram of a Differential Pulse Code Modulation (DCPM) scheme.

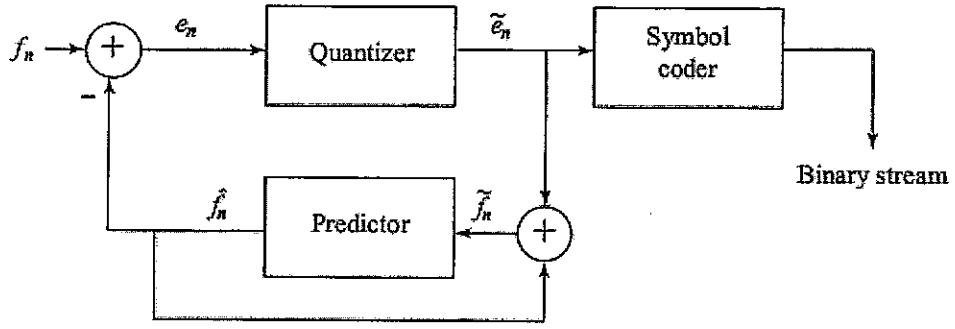

Figure 3

Propose three methods that can be used to reduce the bit rate of the binary stream. The binary stream output is a sequence of binary codes for the input signal f_n.

[6 Marks]

(b) Distinguish between PCM and DPCM for encoding audio signals. With justification, briefly explain which method is likely to give a lower bit rate?

[6 Marks]

(c) Moving Picture Experts Group (MPEG) propose MPEG1 layer 3 or MP3 as a standard for compressing audio signal. The technique used differs from PCM and DPCM. MPEG1-layer 3 is based on the concept of perceptual encoder. With the use of a block diagram, explains how the generic perceptual encoder works.

[8 Marks]

Continued ...

QUESTION 5

(a) A raw colour video is encoded with the following parameters: The resolution is 640x480, 24 bits are used for bit depth in RGB format and the frame rate used is 60 frames per second. Compute the video bit rate.

[3 Marks]

(b) Without using compression, propose a method to reduce the video bit rate without significantly affecting the video quality. Briefly justify the method used and how it relates to video bit rate reduction.

[6 Marks]

(c) Video compression requires more processing time than video de-compression. Explain the reason for the difference in the computational resource required.

[4 Marks]

(d) Design a system to compress a surveillance video signal obtained from a storeroom that is rarely used. The video frames are mostly similar with occasional appearance changes when there are persons passing through the room. The main aim is to reduce the size of the compressed video without degrading the video quality. The proposed video frame compression is JPEG (Joint Photographic Experts Group). Motion estimation will not be performed.

[7 Marks]

End of Paper